1,066,768

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,066,768

Date of Application and filing Complete Specification: Nov. 17, 1964.

No. 46787/64.

Application made in United States of America (No. 324,286) on Nov. 18, 1963.

Complete Specification Published: April 26, 1967.

Index at acceptance:—C1 M(D3, D6, D8, D11, S25A)

Int. Cl.:—C 03 b 19/10

COMPLETE SPECIFICATION

Method and apparatus for manufacturing Glass Beads

We, CORNING GLASS WORKS, a corporation organized under the laws of the State of New York, United States of America, of Corning, New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of glass beads.

One known method for the production of glass beads involves the initial manufacture of glass and the subsequent cooling thereof. The cooled glass, referred to as cullet, is then crushed and screened to the approximate size of the resultant glass beads desired. The screened material is then fed into an apparatus in which a flame travelling upward at low velocity carries the glass particles and causes them to become spheralized while travelling with the flame. The spheralized particles are subsequently collected in suitable troughs or the like adjacent the top or exhaust end of the tower of the apparatus. An example of such apparatus is shown in U.S.A. Patent Specification Numbers 2,619,776 and 2,730,841.

The disadvantage of such known process is that it is uneconomical for large volume production in that the glass which has been reduced to a molten state is cooled to a solid state and after being pulverized is then reheated to a molten state in order to spheralize the pulverized material. The consequent loss of efficiency through two separate and distinct heating steps is obvious. Another disadvantage is that the glass, being a highly abrasive material, is exceedingly detrimental to the customary crushing and similar equipment used for its size reduction consequently, both the equipment and the maintenance thereof is expensive and the maintenance is time consuming. A still further disadvantage of such a method is that a large quantity of glass which was originally melted is lost during pulverization in the form of dust too fine to be used in the process.

Another method for producing glass beads comprises dropping crushed glass particles through an electric arc in which the particles become molten and consequently spheralized. An example of such a process is shown in U.S.A. Patent Specification No. 2,859,560. This method, having all the disadvantages hereinabove noted, has the additional disadvantage of being uneconomical as a result of employing electric heat only in the spheralizing process.

A further known method teaches causing a molten stream of glass to fall forcefully upon a cold contacting surface whereupon the glass is dispersed into droplets. A stream of air is directed at the point of contact of such stream on the surface to assist in dispersing the stream and to remove the droplets therefrom. Such a method is taught in U.S.A. Patent Specification No. 2,965,921. Such a method has the disadvantage of producing a high percentage of fibres and irregularly shaped droplets resulting in a poor quality product.

A still further known process provides for flowing a stream of molten glass into a high velocity carrier gas stream substantially transverse to the stream of molten glass whereupon the glass is caused to disperse. The carrier gas stream is surrounded by a plurality of burners which provide products of combustion at a temperature above the melting point of the glass. The dispersed glass is then separated from the stream and is subsequently cooled and collected. Such a method is disclosed in U.K. Patent Specification No. 844,573.

Among the disadvantages of such a process is that the zone maintained above the melting temperature of the glass, within which the dispersed particles of glass are spheralized, is too short resulting in an exceptionally high percentage of fibres, elongated beads and in an otherwise poor quality product. The temperature of the combustion products from the high velocity burners cannot be maintained above

the melting temperature of the glass for any significant distance from the burners. Further, since the stream of molten glass is relatively small it quickly cools after it leaves the orifice of the body of molten glass, and for many glass compositions the temperature and viscosity of the stream at the point of dispersion is such that much of the glass is dispersed in the form of fibres rather than beads.

Other methods of producing glass beads such as by employing a field of ultrasonic waves, or by introducing a vertical blast flame into a body of molten glass, or the like are also known however, such other methods also have disadvantages such as those listed above.

It is an object of this invention to provide a method and apparatus for forming glass beads which overcomes the heretofore noted disadvantages.

According to the present invention, there is provided a method of producing glass beads comprising the steps of providing a first stream of conditioned molten glass, providing a second stream of high velocity gas substantially transverse to the path of the first stream at a temperature sufficient to maintain the glass at a viscosity below about 500 poises, flowing the first stream of conditioned molten glass into the second stream thereby dispersing the first stream and causing the dispersed glass to be carried along by the second stream, and feeding raw gas into the second stream in which the gas is burned thereby to maintain the second stream at a temperature sufficient to maintain the glass at a viscosity below 500 poises while the dispersed glass is carried by the second stream whereby the dispersed glass spheralizes and forms glass beads.

According to another aspect of the invention, there is provided an apparatus for forming glass beads comprising means for supplying a stream of conditioned molten glass, means for providing a high velocity gas stream along a path substantially transverse to the path of the stream of molten glass whereby the stream of molten glass is dispersed and carried by the high velocity gas stream upon impingement thereof by the gas stream, and means for flowing raw gas into the gas stream to maintain the high velocity gas stream at a temperature sufficient to maintain the glass at a viscosity below about 500 poises while the dispersed glass is so carried, whereby the dispersed glass is spheralized and forms glass beads.

Some preferred embodiments of the invention are illustrated in the accompanying drawings in which:

Figure 1 is a diagrammatic illustration of an apparatus suitable for carrying out the method of this invention, and

Figure 2 is a graph of the temperature within the spheralizing zone as a function of the distance from the burner nozzle along the centre line thereof.

The apparatus illustrated in Figure 1 comprises a glass tank 10 for a body or reservoir of molten glass 12. Molten glass 12 flows from the tank 10 through an orifice 14 forming a stream 16. It is understood that the orifice 14 is of an electrically conductive material, such as metal or the like. An electrode 18 is disposed below and spaced from the orifice 14 adjacent the stream 16. A suitable source 20 of electrical energy is connected to the orifice 14 and the electrode 18. The electrode 18 is not in contact with the stream 16, but an electrical circuit is completed through the stream by means of an arc between the electrode 18 and the stream 16.

In the manufacture of glass beads, the stream 16 of necessity must have a comparatively small diameter, for example less than about 3/8 inches; consequently, the molten glass of the stream quickly cools off after it leaves the orifice 14. By passing regulated amounts of electrical energy through a portion of the stream 16 between the electrode 18 and the orifice 14, the temperature of stream 16 may be carefully regulated and the stream suitably conditioned for subsequent dispersal. The hereinbefore described conditioning is necessary for most glass compositions since the temperature of the body of molten glass itself cannot, as a practical matter, be raised sufficiently due to the physical limitations of the tank materials.

It has been found, however, that certain low viscosity and low melting temperature glasses may be suitably conditioned by controlling the temperature of molten glass 12 within the tank 10. This type of conditioning is possible with glass compositions which do not require a temperature of the body of molten glass 12 in excess of the physical limitations of the tank materials to have a suitable stream temperature and viscosity at the point of dispersion.

It should be noted that without proper conditioning, that is maintaining the stream 16 at a suitable temperature and viscosity at the point of dispersion, an exceptionally high percentage of fibres rather than beads are formed.

Referring again to Figure 1, a burner generally indicated by the numeral 22 having a combustion chamber 24 and an orifice 26, is disposed below the electrode 18. A gaseous fuel-air mixture is fed to the burner, as indicated by the arrow 28, from a suitable source not shown. The gaseous fuel, hereinafter referred to as raw gas, may be any of the common commercial gaseous fuels such as natural gas, manufactured gas, water gas, or the like. The raw gas-air mixture is caused to burn within the combustion chamber 24 and the gaseous products of combustion thereof are emitted through an orifice 26 forming a high velocity gas stream which in turn forms a glass spheralizing zone indicated by dotted lines 30. As the hereinabove described suitably conditioned molten glass stream 16 enters the spheralizing

zone, it is dispersed by the high velocity stream. The term "high velocity stream", as used herein, is defined as a stream having a velocity in excess of about 40 feet per second.

Referring additionally to Figure 2, it is seen that the temperature of the high velocity stream, only a short distance from the burner nozzle, is less than that necessary to maintain the viscosity of most glasses below about 500 poises. The line 32 illustrates a typical temperature distribution of the products of combustion emitted from the burner 22 as a function of the distance from said nozzle. Accordingly, as the molten glass stream 16 is dispersed by the high velocity stream, some glass beads are formed in that portion of the spheralizing zone in which the temperature is sufficient to maintain the glass viscosity below about 500 poises; however, a large amount of glass fibres are formed in the balance of the zone and some are formed in the portion of the zone.

It is believed that large amounts of surrounding air are sucked into the high velocity stream at the root thereof adjacent the exterior of the orifice 26, thereby bringing about a rapid drop in temperature of the zone only a short distance from the orifice. It has been found that by flowing low pressure raw gas directly at the high velocity stream by means of a nozzle 34, the raw gas is caused to burn with the air being sucked into the high velocity stream, as well as the surrounding air, causing the temperature distribution of the spheralizing zone to be as illustrated by the typical temperature distribution line 36 of Figure 2. The raw gas is fed to the nozzle, as indicated by the arrow 38, from a suitable source not shown. It is readily seen that the temperature illustrated by the line 36 is higher than that necessary to maintain the viscosity of most glasses below about 500 poises. Accordingly, glass beads are caused to form not only at one end of the spheralizing zone but throughout it. Any fibres which may be formed at the beginning of the zone are caused to break up and coagulate thereby forming beads as they are being carried along by the high velocity stream. This fibre break-up and coagulation is not possible without feeding raw gas into the spheralizing zone as heretofore described, because the temperature of the zone would be below that necessary to maintain the glass at a suitable viscosity.

The glass beads so formed are separated from the high velocity stream by gravity and are caused to fall into a suitable collecting tank 40. By disposing a fluid medium 42 within the tank 40, the glass beads may be tempered as they are collected in the tank. Suitable fluid tempering mediums are water, oils and like liquids.

The method and apparatus of this invention are suitable for forming glass beads of any desired glass composition and one familiar with the glass art may readily select a suitable glass. The amount of electrical energy passed through the molten glass stream, if any, will depend upon the composition of the glass as well as the size of the glass beads desired. The type of fluid for tempering the glass beads will depend upon the rate of cooling desired and consequently the strength of the beads, as well as on the composition and size of the glass beads. One familiar with the art can readily determine the amount of electrical energy required and the proper type of tempering fluid to use.

A typical example of carrying out the present invention is illustrated by the following description with reference to Figures 1 and 2. A body of molten glass 12, having a temperature of about 1400°C., was disposed in a glass tank having a 1/8 inch diameter orifice. The glass was of a composition as illustrated by Example 6 of U.K. Patent Specification No. 629,049. A stream of molten glass having a temperature of approximately 1175°C. was flowed into a substantially horizontal high velocity stream having a velocity ranging from about 250 to 350 feet per second. The high velocity stream was produced by burning a natural gas-air mixture, having a gas-air ratio of approximately 1:10, at a rate of approximately 2000 cubic feet per hour, in the burner 22. The natural gas had a heat content of approximately 1000 BTU per cubic foot. The electrode 18 was spaced about midway between the orifice 14 and the burner 22. Raw gas of the same type as used in the burner 22 was fed through the nozzle 34 at the rate of approximately 1100 cubic feet per hour creating a spheralizing zone of approximately 36 inches in length with a temperature distribution substantially as illustrated by the line 36 of Figure 2. About 2500 watts of electric energy was caused to pass through the molten stream 16 between the electrode 18 and the orifice 14. The fluid tempering medium was water. With glass flowing at the rate of approximately 25 pounds per hour, glass beads having compressive strengths of up to approximately 400,000 pounds per square inch were produced in sizes ranging from approximately 8 to approximately 40 U.S.A. Standard mesh size, with less than 2 per cent of the total being glass fibres.

Another example of carrying out the present invention is illustrated by the following. A body of molten low viscosity soda lime glass 12, having a temperature of about 1425°C., was disposed in a glass tank having a 3/32 inch diameter orifice. A stream of molten glass having a temperature of approximately 1235°C and a viscosity of approximately 50 poises was flowed into a substantially horizontal high velocity stream having a velocity ranging from about 250 to about 350 feet per second. The high velocity stream was produced by burning a natural gas-air mixture, having

a gas-air ratio of approximately 1:10, at a rate of approximately 1650 cubic feet per hour, in burner 22. The burner 22 was disposed about 4 inches below the orifice 14. The natural gas had a heat content of approximately 1000 BTU per cubic foot. Raw gas of the same type as used in the burner 22 was fed through the nozzle 34 at the rate of approximately 1000 cubic feet per hour creating a spheralizing zone of approximately 36 inches in length. The fluid tempering medium was water. With glass flowing at the rate of approximately 17 pounds per hour, glass beads having compressive strengths of up to approximately 400,000 pounds per square inch were produced in sizes ranging from approximately 8 to approximately 40 U.S.A. Standard mesh size, with less than 2 per cent of the total being glass fibres.

It will be appreciated by those skilled in the art that the size of the resultant glass beads by the described method and apparatus are dependent on a number of variable factors. These factors include the viscosity of the glass, the composition of the glass, the diameter of the orifice 14, the amount of electrical energy passed through the stream 16, the velocity of the combustion products in the spheralizing zone, the amount of raw gas fed into the zone, and other factors. It is readily seen that a plurality of the streams may issue from the tank 10 thereby increasing the productivity of the apparatus.

WHAT WE CLAIM IS:—

1. A method of producing glass beads comprising the steps of, providing a first stream of conditioned molten glass, providing a second stream of high velocity gas substantially transverse to the path of the first stream at a temperature sufficient to maintain the glass at a viscosity below about 500 poises, flowing the first stream of conditioned molten glass into the second stream thereby dispersing the first stream and causing the dispersed glass to be carried along by the second stream, and feeding raw gas into the second stream in which the gas is burned thereby to maintain the second stream at a temperature sufficient to maintain the glass at a viscosity below 500 poises while the dispersed glass is carried by the second stream whereby the dispersed glass spheralizes and forms glass beads.

2. A method as claimed in claim 1 wherein the glass is conditioned by passing an electric current through the first stream.

3. A method as claimed in claim 1 further comprising the steps of separating the beads from the second stream, cooling the beads at a predetermined rate, and collecting the cooled beads, whereby the beads are formed of substantially spherical shape, substantially free from fibres, and are suitably tempered.

4. A method as claimed in claim 3 wherein the beads are cooled by immersion in a liquid medium.

5. A method of producing glass beads substantially as described with reference to the accompanying drawings.

6. An apparatus for forming glass beads comprising means for supplying a stream of conditioned molten glass, means for providing a high velocity gas stream along a path substantially transverse to the path of the stream of molten glass whereby the stream of molten glass is dispersed and carried by the high velocity gas stream upon impingement thereof by the gas stream, and means for flowing raw gas into the gas stream to maintain the high velocity gas stream at a temperature sufficient to maintain the glass at a viscosity below about 500 poises while the dispersed glass is so carried, whereby the dispersed glass is spheralized and forms glass beads.

7. An apparatus as claimed in claim 6 further comprising means for separating the glass beads from the glass stream, means for cooling the glass beads at a predetermined rate, and means for collecting the cooled beads.

8. An apparatus as claimed in either of claim 6 or 7 wherein means are provided for adding heat to the stream of molten glass, the said means comprise, an electrically conductive orifice through which the stream of molten glass can pass, an electrode disposed intermediate the orifice and the high velocity gas stream and spaced from the stream of molten glass to form an electric arc therebetween, and means to provide electrical energy electrically connected to the orifice and the electrode whereby an electrical circuit is completed through the stream by the arc.

9. An apparatus as claimed in claim 8 wherein the means for providing a high velocity gas stream comprise a gas burner.

10. An apparatus for forming glass beads substantially as described with reference to the accompanying drawings.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1967. Published by The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

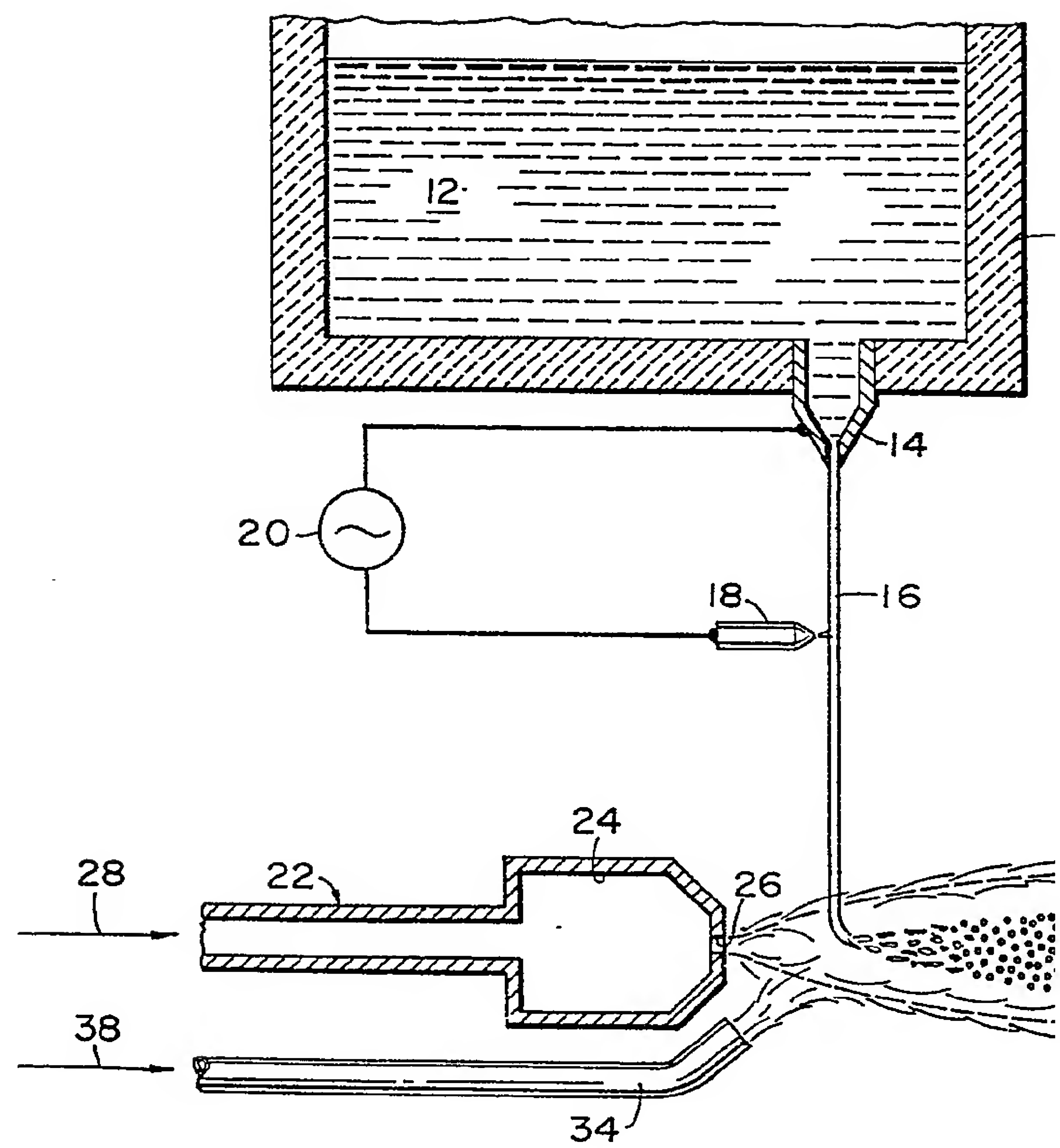
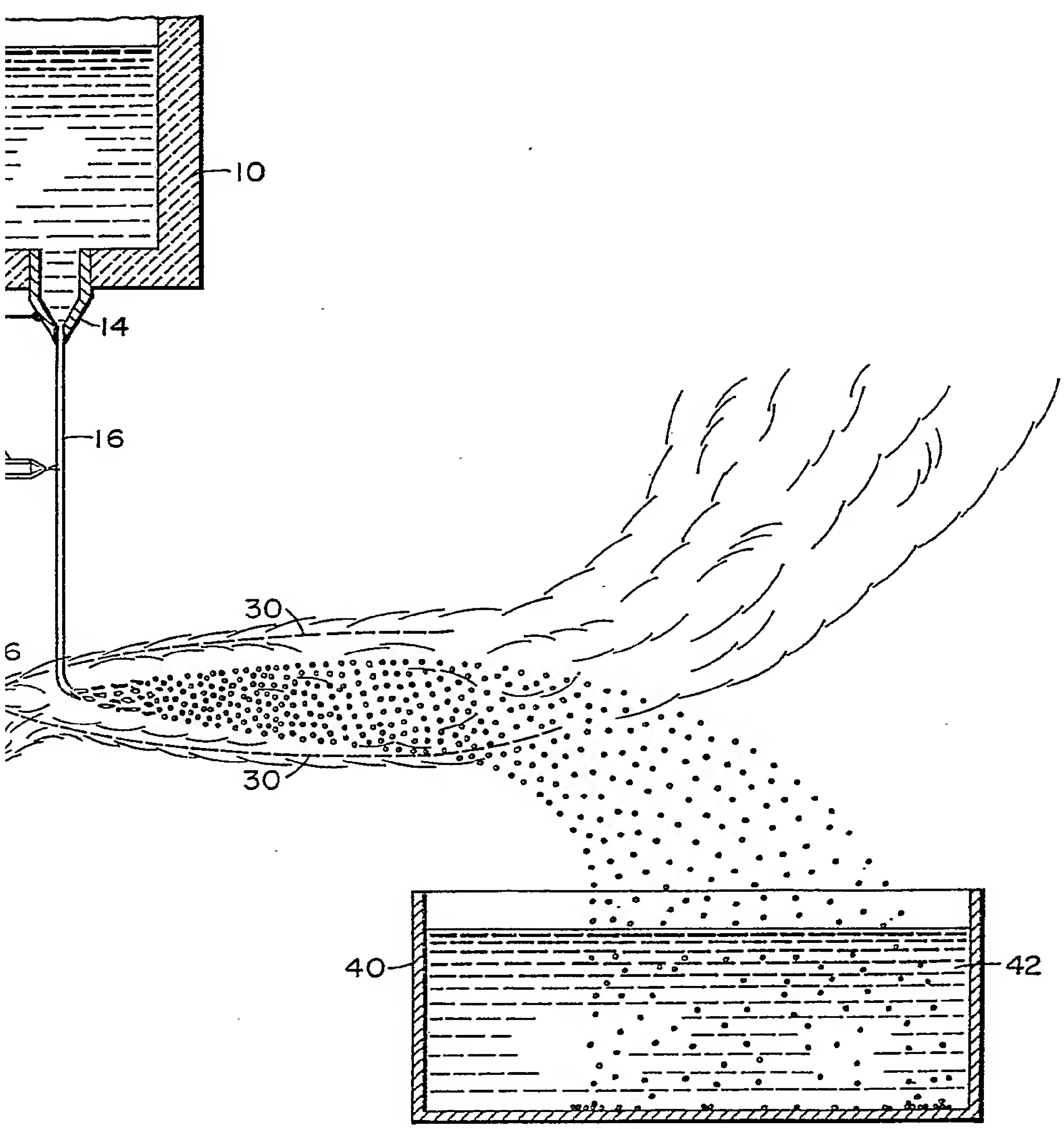


FIG.1

1066768 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1



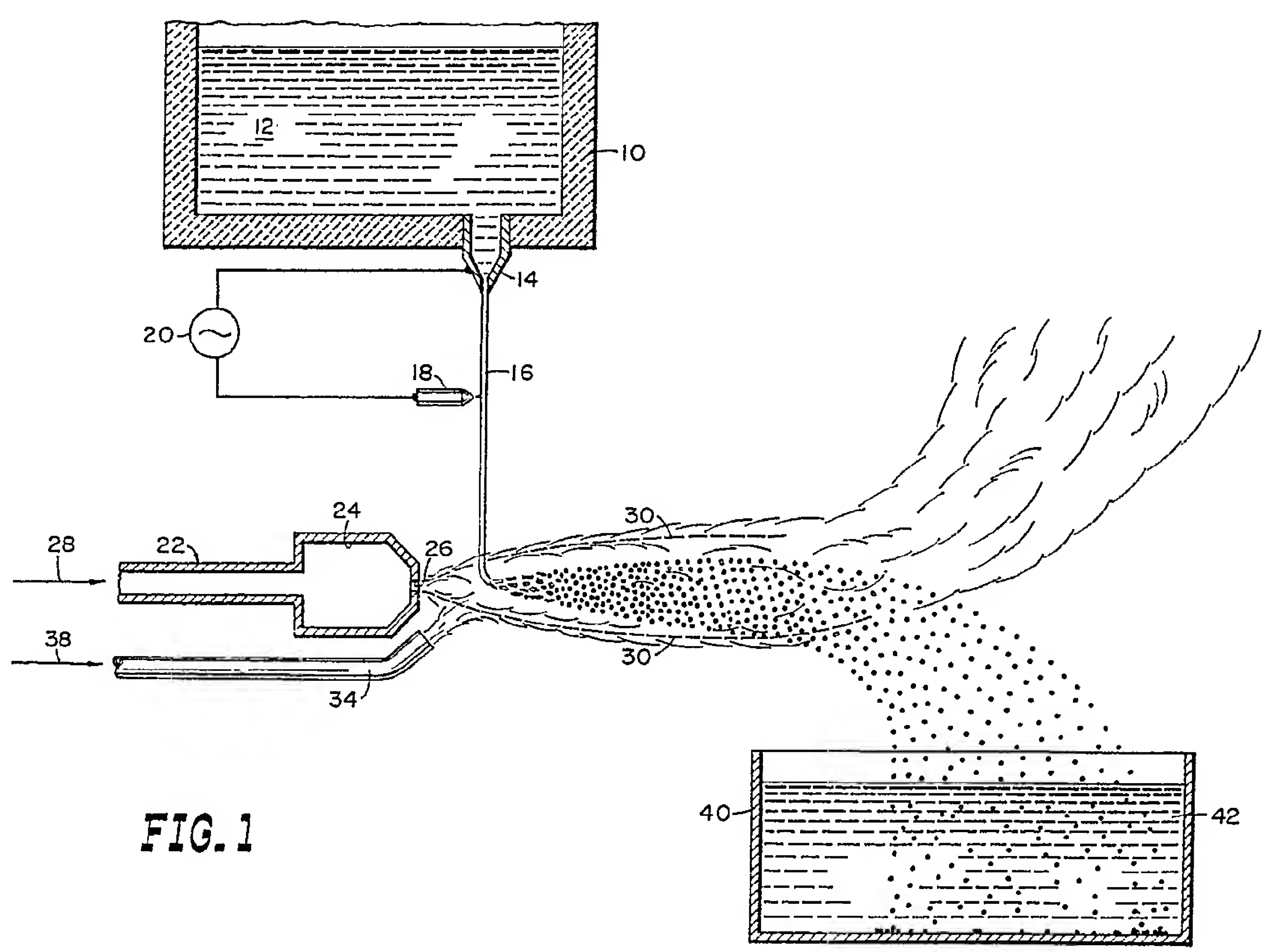


FIG. 1

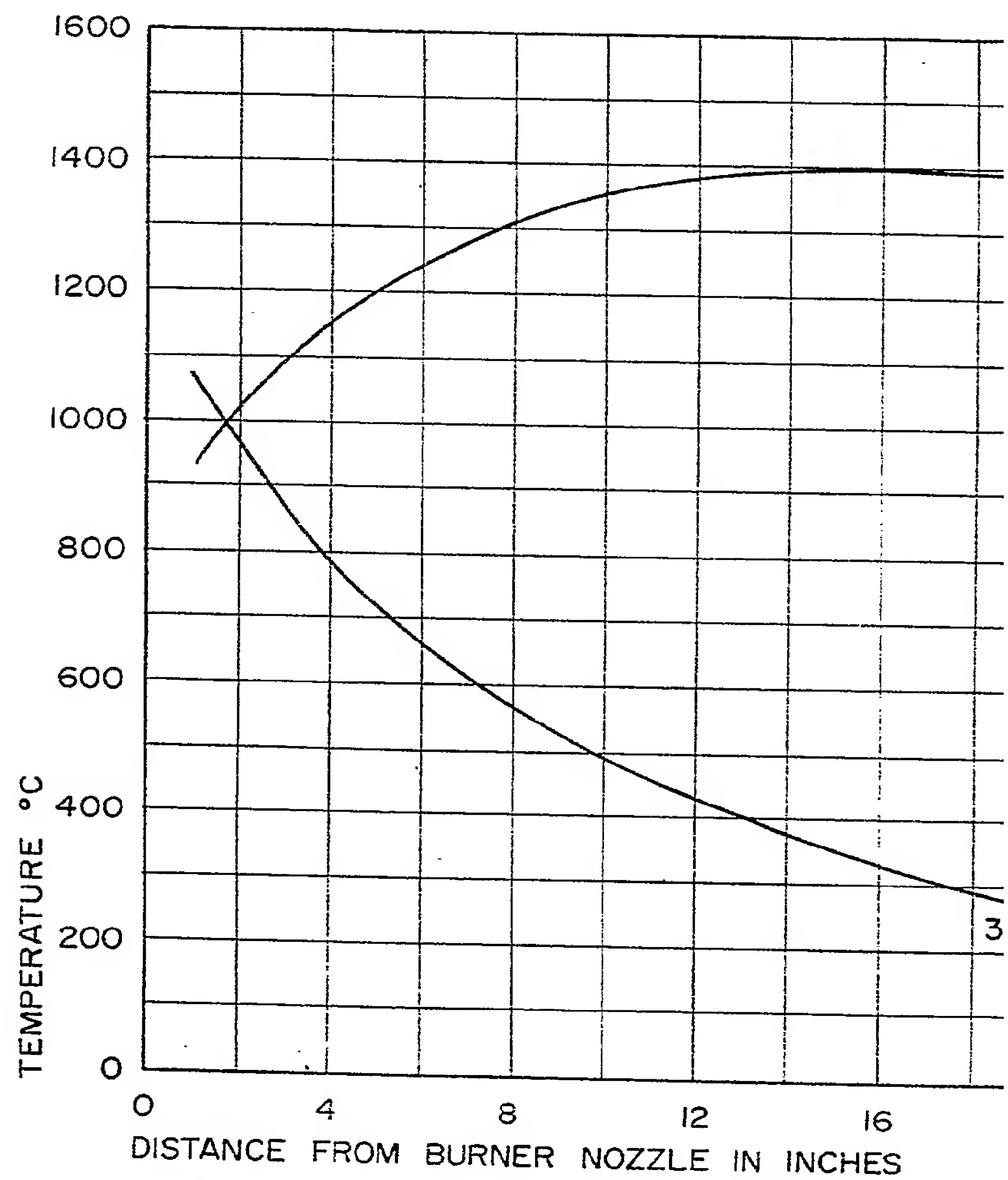
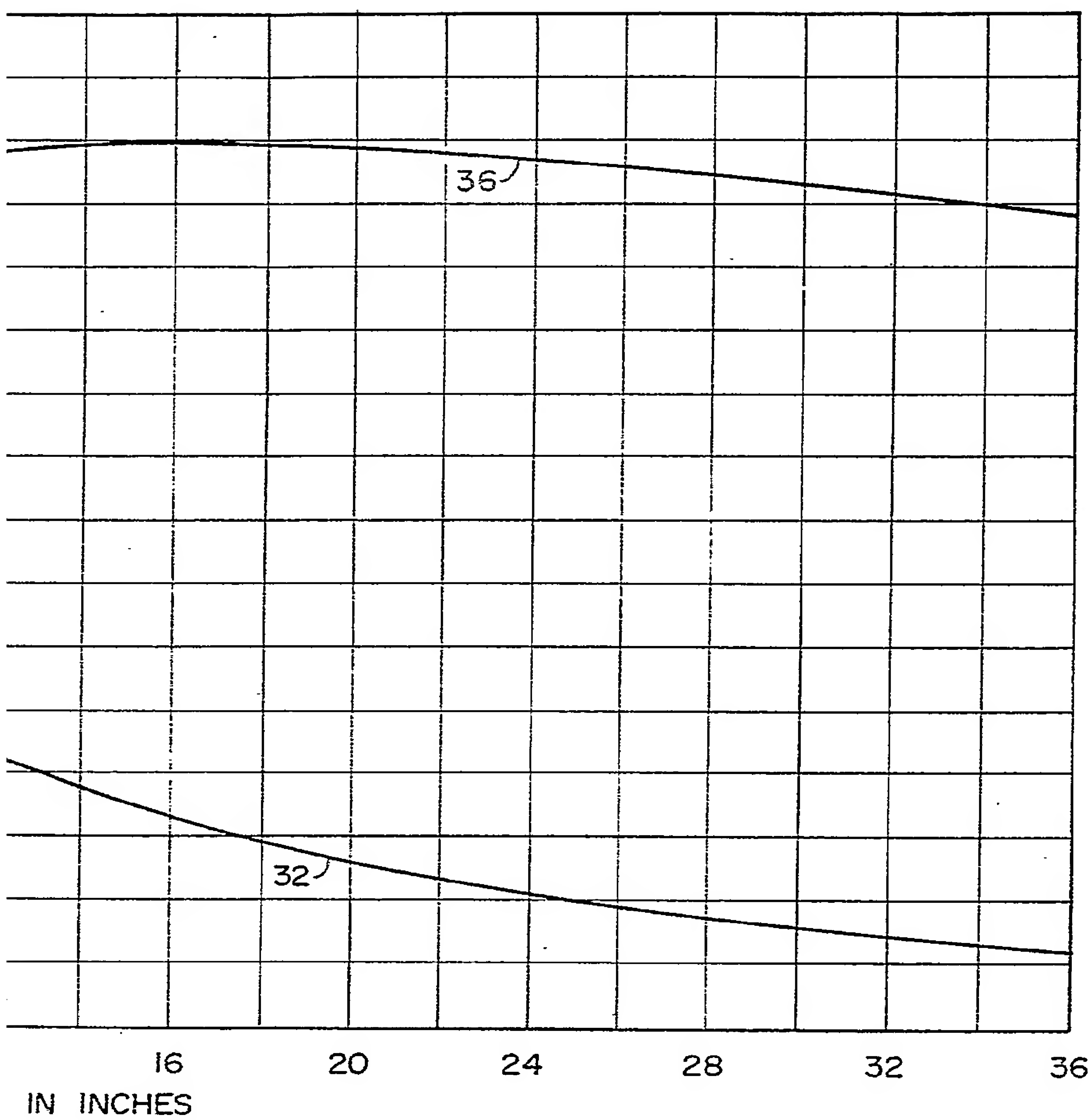
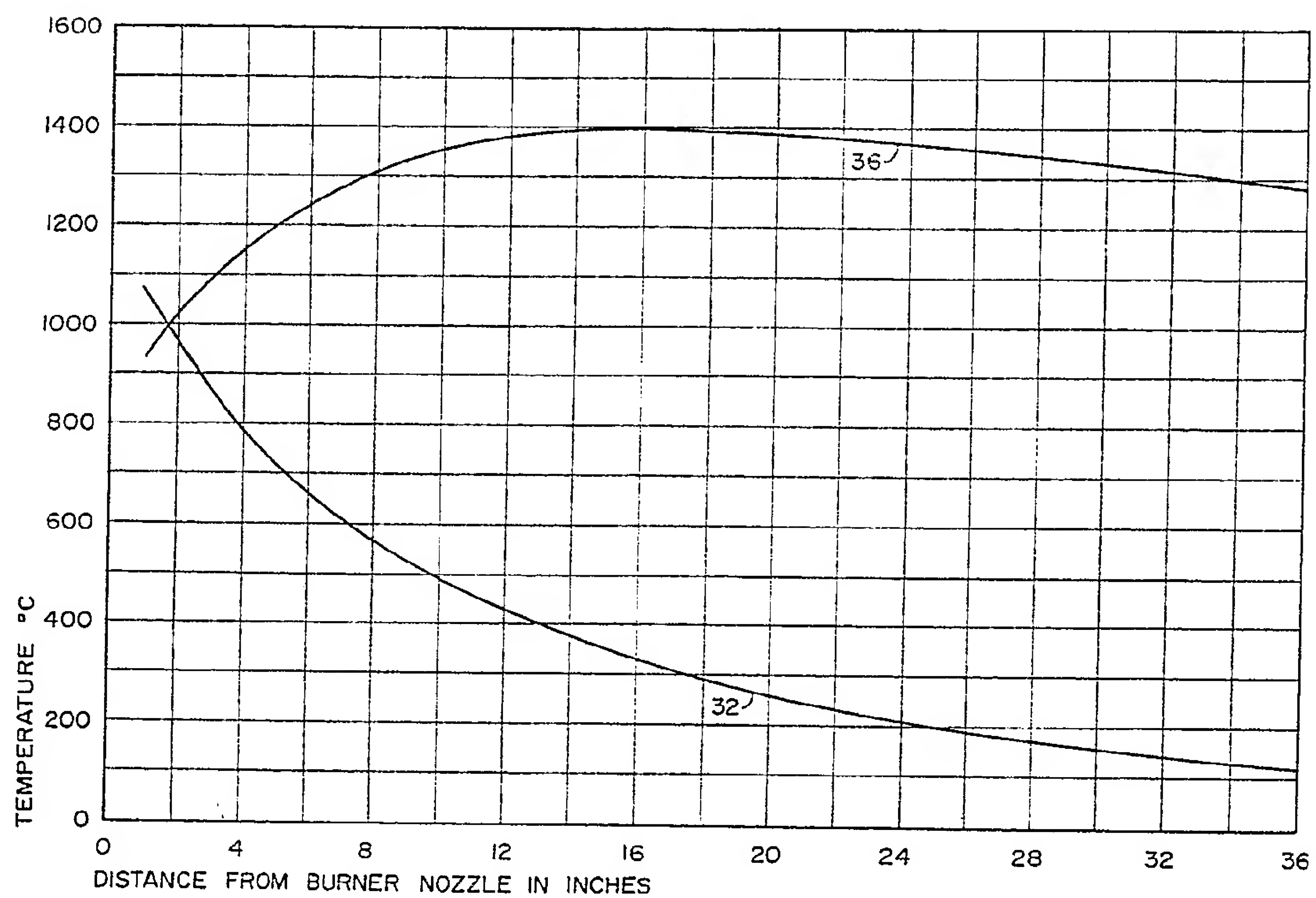

1600
1400
1200
1000
800
600
400
200
0
TEMPERATURE °C
0
4
8
12
16
DISTANCE FROM BURNER NOZZLE IN INCHES
3

FIG. 2


36
32
16
20
24
28
32
36
IN INCHES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1200
1000
800
600
400
200
0
TEMPERATURE °C
0
4
8
12
16
20
24
28
32
36
DISTANCE FROM BURNER NOZZLE IN INCHES
36
32

FIG. 2